Indian J. Fish., 61(4) : 98-103, 2014

Vulnerability assessment of coastal fisher households in Kerala: A climate change perspective

SHYAM. S. SALIM, V. KRIPA, P. U. ZACHARIAH, ANJANA MOHAN, T. V. AMBROSE AND MANJU RANI

Central Marine Fisheries Research Institute, Kochi - 682 018, Kerala,India
e-mail: shyam.icar@gmail.com

ABSTRACT

Climate change, a global challenge facing mankind necessitates governments to develop mitigation and adaptation plans. The climate change has multidimensional impacts on environment, fishery, social, economic and development drivers. The perception level of the primary stakeholders leads to their proactive participation in disaster management plans. The present paper assessed the vulnerability of 318 fisher households in Alappuzha District of Kerala using PARS (parameter, attribute, resilient indicator and score) methodology. The methodology provides prioritisation and ranking of the different impacts as perceived by the fishers on environment, fishery and socio-economic parameters. The vulnerability indices were worked out for the fisher households. The fisher's perception revealed that fishery was most impacted followed by economic and environmental impacts. Social impact was the least as opined by fishers. The study indicates that long term effects of climate change aren't realised/perceived/impacted much among the fisher households. The fishers were more prone to loss in fishing days due to erratic monsoon. The results suggest immediate need to improve the primary stakeholders awareness by involving them in disaster preparedness, management and mitigation planning as well as implementation process.

Keywords: Adaptation, Coastal vulnerability, Mitigation, PARS methodology, Rank based quotient, Vulnerability index

Introduction

Climate change, the highly debated global phenomenon is no more a myth but a reality. Climate change is a phenomenon where the distribution of weather pattern changes spatially and temporally, modifying the distribution and productivity of marine as well as freshwater species and impacts the sustainability of fisheries and aquaculture, eventually on the livelihoods of the communities that depend on fisheries. The effect of sea level rise means that coastal fishing communities are vulnerable and are in the front line of the deleterious effects of climate change. Changing seawater temperature and current flows are likely to cause shifts in the distribution of marine fish stocks, with some areas benefiting while others lose. These changes may have impacts on the nature and value of commercial fisheries. Many artisanal fishers are extremely poor and are often socially and politically marginalised with limited access to healthcare, education and other public services. With little capacity to adapt, the small-scale and migrant fishers are highly vulnerable to losses of natural capital consequent to climate impacts.

Vulnerability is a condition wherein the internal ability or lack thereof to cope, recover and adapt to climate stress (Kasperson *et al*., 2003). Vulnerability has emerged as a central concept for understanding the impacts of climate change and natural hazards, in order to develop adequate risk management strategies. Coastal vulnerability describes the susceptibility of the natural system and of coastal societies (persons, groups or communities) towards coastal hazards. Assessing coastal vulnerability is an important prerequisite to identify the areas of high risk, factors contributing to the risk and the ways to reduce the risk (Brooks, 2005). Studies on climate change impacts and vulnerability of social and ecological systems perhaps have begun with the seminal work of Timmerman (1981) who provided intellectual underpinning for linking the concepts of vulnerability resilience and climate change. Of the major impacts of climate change projected in marine fisheries, sea level rise and consequent changes in habitat, frequency of extreme events, variability in the catch and revenue are the most important (Vivekanandan, 2007; 2011). Kumar (2003) constructed a coastal vulnerability index by hypothesising

vulnerability as a function of impact on the district and the resistance as well as resilience of the district in responding to the impact it experiences. Vijayakumaran (2008) approximated direct scores made for 39 factors under seven dimensions based on the information obtained from the villages. The scores were subjected to further analysis for constructing the relative vulnerability profiles of different villages by adopting a slightly modified form of the model used by Patnaik and Narayanan (2005). Szlafsztein and Sterr (2007) formulated an index combining a number of separate variables that reflect natural and socio-economic characteristics that contribute to coastal vulnerability due to natural hazards. In the context of the present paper, vulnerability is defined as the fishers inherent inability or lack to cope with or recover from and adapt to climate stress.

The fishers are believed to be unaware if not unwilling to participate in the climate change mitigation and adaptation due to the level of awareness and participation in the climate change dialogues and process. The perception of the fishers will be important in the development of mitigation plans. Variables that identify the demographic diversity of a community can help managers understand the characteristics of the community they are working with and plan relevant adaptation strategies. The objectives of this study are to develop a methodological framework for assessing the coastal vulnerability of fisher households to analyse perception of fisher's on climate change effects and to develop a bottom up approach in climate change mitigation and adaptations involving stakeholders' participation.

Kerala is one of the major coastal states of the country with a coastline of 590 km distributed across 222 fishing villages and 187 landing centers. The marine fish production has been over 6.6 lakh t with people involved in the primary and secondary sector amounting to around 2.1 lakh. Kerala houses a fishermen population of around 6,10,165 with a density of 2,740 people per fishing village which is much higher than the country average (1,099) (GOI, 2010). There are nine coastal districts in Kerala *viz.*, Thiruvananthapuram, Kollam, Alappuzha, Ernakulum, Thrissur, Malappuram, Kozhikode, Kannur and Kasaragod. The vulnerability index developed based on demography, occupation, infrastructure, climate components and fishery components for the coastal districts by Shyam *et al*. (2014) showed that Alappuzha District had the highest vulnerability followed by Kozhikode and Thiruvananthapuram and hence Alappuzha District was selected for the present study.

Materials and methods

Selection of coastal villages

Coastal villages from Alappuzha District for the study were selected based on different parameters *viz*., socio-economic factors, number of families below poverty line, adult-child ratio, average family size, gender ratio, literacy rate, dependence on fishing activities, craft and gear inventories, participation in cooperatives and ancillary activities. The study was conducted for a period of 6 months from May to November 2012. Three hundred and eighteen fishing households spread across three fishing villages were selected for the study.

Construction of coastal vulnerability indices

The samples were drawn based on the distribution of households along the coastline. The data were collected across the villages using a pre-structured schedule that included details on general particulars including family details, education, asset particulars, savings, farming system, livestock and mostly on climate change awareness perception and its causal factors. The level of awareness preparedness and mitigation, alternate avocation options, community involvement and mobilisation and the level of governmental support and requirements were also included.

The vulnerability indices were constructed using parameter, attribute, resilient indicator and score (PARS) methodology, a conceptual framework developed for assessing the climate change vulnerability of coastal livelihoods. The different parameters and attributes used in the PARS methodology frame work are presented in Fig. 1.

PARS provides prioritisation and ranking of different impacts as perceived by the fishers and the frame work allows adequate distribution between fishing. The fishers were asked to rank between 1 – 5 indicating the severity of the vulnerability: 5 indicates very high, 4 - high, 3 - medium, 2 - low and 1- negligible/marginal. Each and every parameter will lead to different attributes and the attributes will lead to different statements or resilient indicators which will be based on different scores. The rank based quotient technique was used to analyse the scores and the ranks were in such a way the most affected attribute will get the highest ranking. PARS methodology was analysed using rank based quotient (RBQ) formula of Sabarathnam (1988):

$$\text{Rank based quotient} = \sum_{i=1}^{n} (Fi)\,(n+1-i) \times \frac{100}{Nn}$$

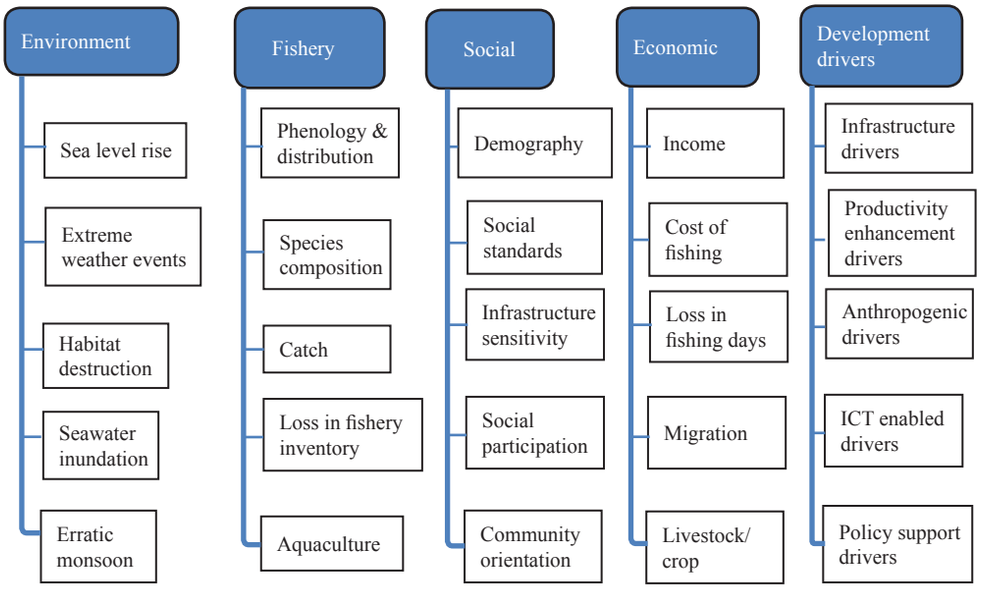

Fig. 1. Parameter and attributes used in PARS methodology frame work

where, F_i = number of farmers reporting a particular problem under i^{th} rank, n = number of problems identified and N= number of farmers.

The values were measured for each statement and the analysis was done based on 125 statements in the schedule, which are related to climate change.

Results and discussion

The methodology adopted was useful in identifying the most relevant criteria significant to climate change impacts in coastal areas based on the ranks assigned to the vulnerability factors *viz*., parameters and attributes. This kind of bottom up approach would help the climatologists and policy makers to implement climate adaptation plans for the district, state and finally for the country.

Alappuzha comprises three taluks of Karthikapalli, Ambalapuzha and Cherthala extending from Azheekal in south to Aroor in north. The district harbours 30 coastal fishing villages and vulnerability index was calculated for each coastal village (Fig. 2). Based on the indices, two

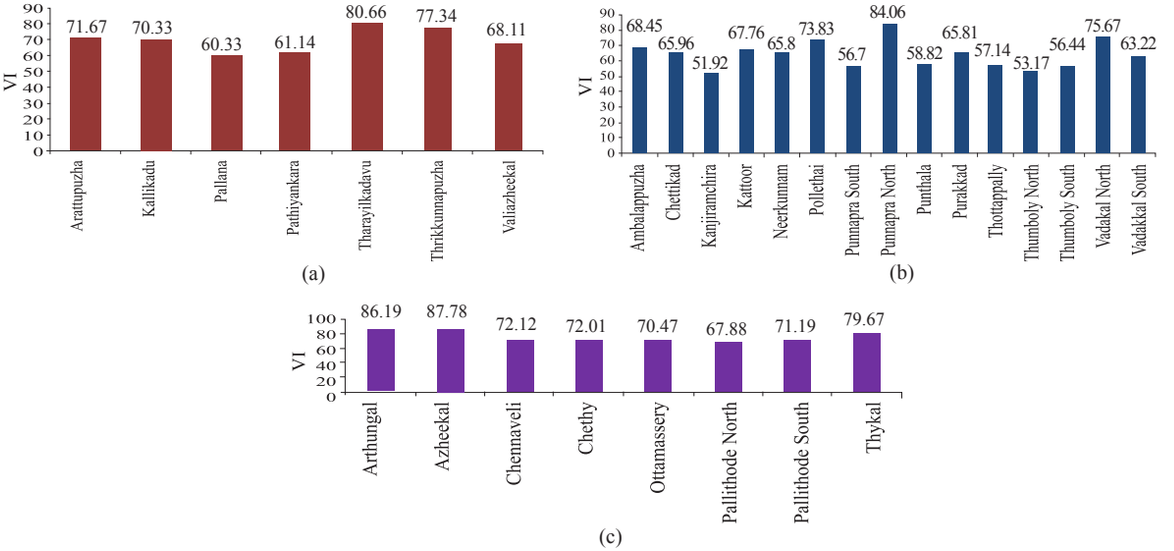

Fig. 2. Vulnerability indices (VI) for fishing villages in the three taluks in Alappuzha District (a) Karthikappally, (b) Ambalapuzha, (c) Cherthala

villages *viz.*, Arthungal and Chethy were selected which scored high on vulnerability and further Thumboly South was also selected considering the emerging possibilities of alternate avocations.

Fishers' perception on the effect of climate change

PARS methodology was applied in an effort to understand the indicator factors of coastal vulnerability in the selected fishing villages of Alappuzha District, in order to scale up the impacts, adaptations and mitigation plans of coastal livelihoods to the district level. The application of PARS methodology in this study helped to assess the impact of climate change on the five different parameters considered. The results emerging from the selected fisher households in all the three villages indicated that climate change has mostly impacted fishery based on fishers' perception on different attributes followed by economic and environmental factors in Chethy. In Thumboly fishing village, the environmental impacts and economic impacts followed fishery impacts, whereas social and economic attributes were impacted next to fishery in Arthungal (Fig. 3). The data on the composite villages indicated that fishery is the most impacted parameter as a result of climate change followed by economic and environmental impacts. Social parameter is the least impacted as perceived by the fishers (Fig. 4).

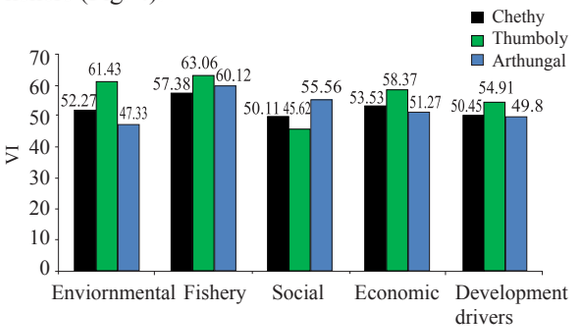

Fig. 3. Climate parameter assessment across coastal villages selected for the study; VI: Vulnerability index

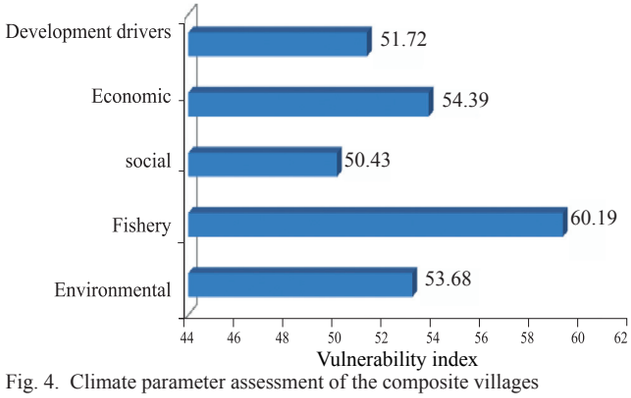

Fig. 4. Climate parameter assessment of the composite villages

Attribute analysis of fishing villages

The attribute analysis of different parameters indicated that the fishery was impacted mostly by catch. The analysis on the resilient indicator to this attribute indicated that fish catch decreased drastically over the years while effort increased fairly. The attributes, phenology and distribution as well as species composition followed catch. According to fishers, coastal fishes migrated to open sea, pelagic fishes to deeper waters and a shift in spawning season of major fishes has taken place along the coast due to climate change. Aquaculture practices are comparatively low in Alappuzha District and in fishers' perception, the least impacted attribute is aquaculture (Fig. 5).

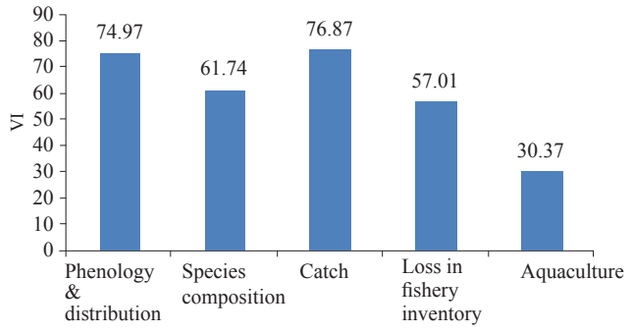

Fig. 5. Attribute analysis of climate change impacts on fishery; VI: Vulnerability index

According to fishers' perception, economic attributes were impacted next to fishery in the context of climate change. The economic attribute *viz.*, cost of fishing was the most limiting factor followed by income effect and loss in fishing days. Cost of fishing has increased on account of changed fishing ground and increased fuel cost. The income effect was impacted due to decreased level of income, increase in cost of living and seasonality in employment combined with minimal alternate avocations. The fishers' perception is that the fishing ground has considerably changed which resulted in increased cost of fishing. Livestock and crops were found to be the least impacted attributes (Fig. 6).

Environmental impacts followed fishery and economic parameters with attribute on monsoonal fluctuation exhibiting the most significance followed by sea level rise and seawater inundation.With respect to monsoonal fluctuations, the respondents perceived that there is substantial decrease in rainy days over the years and erratic monsoon was noticed. There was a perception that substantial increase in sea level and coastal erosion has taken place in the fishing villages of Alappuzha which impacted fishing and allied activities of fishermen (Fig. 7).

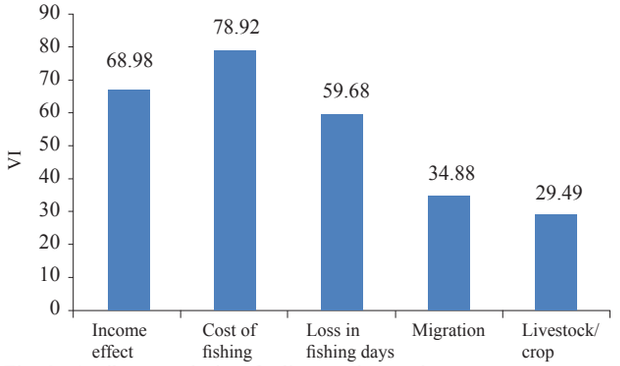

Fig. 6. Attribute analysis of climate change impacts on economy VI: Vulnerability index

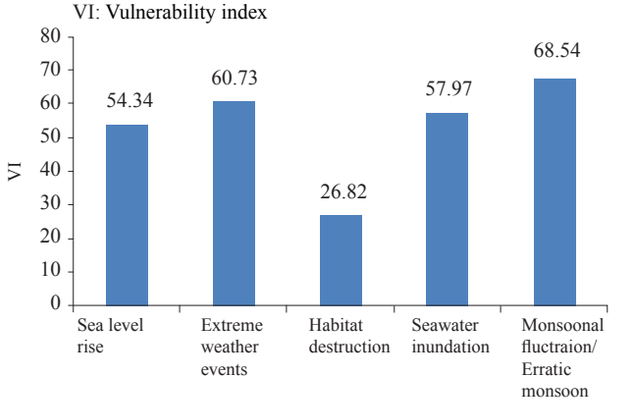

Fig. 7. Attribute analysis of climate change impacts on environment VI: Vulnerability index

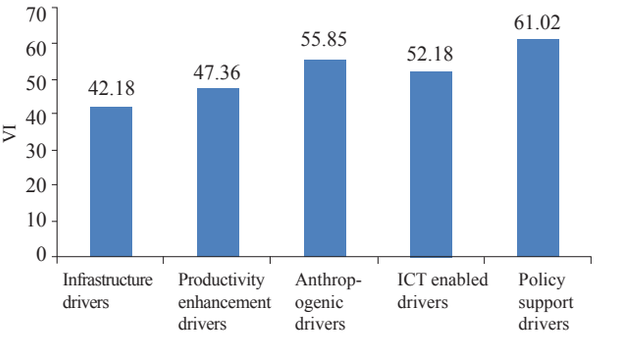

Fig. 8. Attribute analysis of climate change impacts on development drivers; VI: Vulnerability index

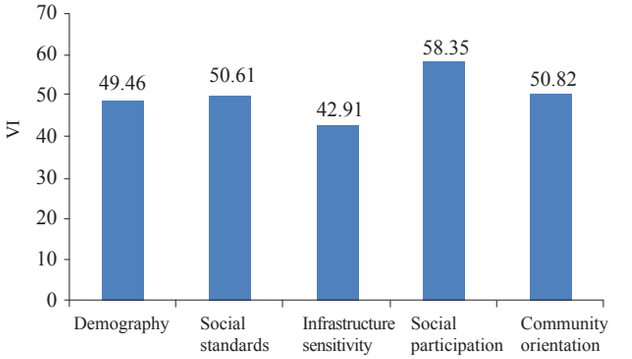

Fig. 9. Attribute analysis of climate change impacts on social factors VI: Vulnerability index

The perception on the development drivers impacting climate change in the fisher households was conceived at a low level. The attribute on policy support drivers ranked most, followed by anthropogenic drivers and ICT enabled drivers while infrastructure drivers were least impacted. Fishers perceive that the response to disaster relief suffers time lag, rehabilitation measures lack clarity in planning as well as implementation and saving cum relief measures are inadequate. Anthropogenic drivers like coastal tourism and related activities have resulted in increased use of plastic. The infrastructure driver is impacted due to unregulated development of industries and transportation facilities (Fig. 8).

Social factors were the least impacted, among which social participation is the highly impacted attribute followed by community orientation and social standards with infrastructure being the least impacted attribute. Social participation is impacted by negligible training programmes and minimal sharing of technical knowledge and awareness. Community based grass root planning, affiliation to NGOs and community groups were minimal (Fig. 9).

The results of the study clearly indicate that the long term effects of climate change aren't impacted much among the fisher households. Fishers perceive that the fishery and economic parameters are of importance in the climate change adaptation and mitigation plans. The level of awareness is low which indicate that the fishers couldn't correlate environmental changes consequent to climate change to their livelihood. The fishers were prone to loss in fishing days and erratic monsoon. There is need to improve on the awareness of fishers to climate change by involving them in the disaster preparedness and planning process. Thus a bottom up approach involving the primary stakeholders along with the community will adequately position them to climate change adaptation and mitigation, by augmenting their traditional knowledge. The alternative avocations available across the different fishing villages need to be strengthened in order to negate the different risks and uncertainties of climate change for ensuring a climate change informed fishers in future.

Acknowledgements

The authors are thankful to the Director, CMFRI, Kochi for his guidance and support. The study was conducted with financial support from ICAR-NICRA project.

References

Brooks, N., Adger, W. N. and Kelly, P. M. 2005. The determinants of vulnerability and adaptive capacity at the national level and the implications for adaptation. *Global Environmental change*, 15: 151-163.

Kasperson, J. X., Kasperson, R. E., Turner II, B. L., Schiller, A., Hsieh, W. H. 2003. Vulnerability to global environmental change. In: Diekmann, A., Dietz, T., Jaeger, C. and Rosa, E. S. (Eds.), *The human dimensions of global environmental change*. MIT, Cambridge, MA, 100(14) : 8074-8079.

Kumar, K. 2003. Vulnerability and adaptation of agriculture and coastal resources in India to climate change. *EERC Working Paper Series, NIP-4*, Madras School of Economics, Chennai, p. 18-44.

GOI 2010. *Marine fisheries census 2010 Kerala, Part II (6)*. Govt. of India, Ministry of Agriculture, Dept. of Animal Husbandry, Dairying & Fisheries and Central Marine Fisheries Research Institute, Indian Council of Agricultural Research, New Delhi, p. 33-48.

Patnaik, U. and Narayanan, K. 2005. *Vulnerability and climate change: An analysis of the eastern coastal districts of India,* International Workshop on Human Security and Climate Change, 21-23 June 2005, Oslo, p.1-20.

Sabarathnam, V. E. 1988. *Manual on field experience training for ARS Scientists*, National Academy for Agricultural Research Management, Indian Council of Agricultural Research, Hyderabad.

Shyam S. Salim, Kripa, V., Zachariah, P. U., Nivedita Shridhar and Ambrose, T. V. 2014. Climate change awareness, preparedness and adaptation and mitigation strategies: Fisherfolk perception in coastal Kerala, *J.Aquat. Biol. Fish.,* 2: 670-681.

Szlafsztein, C. and Sterr, H. 2007. A GIS-based vulnerability assessment of coastal natural hazards, State of Para, Brazil. *J. Coastal Conservation*, 11(1): 53–66.

Timmerman, P. 1981. Vulnerability, resilience and the collapse of society. *Environmental monograph,1*. Institute for Environmental Studies, Toronto, p. 1-42.

Vivekanandan, E. 2007. *Impact of climate change on marine fisheries. Seafood Export J.,* 37 (4): 5-9.

Vivekanandan, E. 2011. Marine fisheries policy brief–3, Climate change and Indian farine fisheries. *CMFRI Special publication*, 105: 97 pp.

Vijayakumaran, K. 2008. Developing vulnerability indices - the art of encapsuling the obvious. *Course manual, Winter school on impact of climate change on Indian marine fisheries,* Central Marine Fisheries Research Institute*, Cochin,* p.154-158.

Date of Receipt : 30.04.2013
Date of Acceptance : 12.06.2014